STRUCTURAL MECHANICS (CV-402)

COMPLETE EXAM PREPARATION NOTES

Structural Mechanics (CV-402) – Civil Engineering

1. The property of a material which helps it to remain in a deformed state is called:

A. Elasticity

B. Plasticity

C. Ductility

D. Brittleness

Answer: B. Plasticity

2. The property of a material by which it returns to its original position after removal of external force is:

A. Plasticity

B. Elasticity

C. Ductility

D. Malleability

POLYTECHNIC
HELPDESK

Answer: B. Elasticity

3. According to Hooke's Law, the ratio of stress to strain is called:

A. Poisson's ratio

B. Modulus of Elasticity

C. Modulus of Rigidity

D. Bulk Modulus

Answer: B. Modulus of Elasticity (Young's Modulus)

4. The SI unit of stress is:

A. N

B. N/m

C. N/m^2

D. kg/m^2

Answer: C. N/m^2 (Pascal)

5. The maximum shear force in a cantilever carrying a point load W at the free end is:

A. W/2

B. W

C. 2W

D. WL

Answer: B. W

6. The maximum bending moment in a cantilever carrying a point load W at the free end occurs at:

A. Free end

B. Mid-span

C. Fixed end

D. Everywhere equal

Answer: C. Fixed end

7. A beam having one end fixed and the other end free is called:

A. Simply supported beam

B. Cantilever beam

C. Continuous beam

D. Fixed beam

Answer: B. Cantilever beam

POLYTECHNIC HELPDESK

8. A beam having more than two supports is called:

A. Cantilever beam

B. Fixed beam

C. Continuous beam

D. Overhanging beam

Answer: C. Continuous beam

9. Bending moment is maximum at a section where shear force is:

A. Maximum

B. Minimum

C. Zero

D. Infinite

Answer: C. Zero

10. For a beam carrying concentrated point loads, the bending moment diagram consists of:

A. Parabolic curves

B. Straight lines

C. Circular curves

D. Horizontal lines only

Answer: B. Straight lines

11. For a beam carrying uniformly distributed load (UDL), the bending moment diagram is:

A. Straight line

B. Parabolic curve

C. Circular curve

D. Horizontal line

Answer: B. Parabolic curve

POLYTECHNIC HELPDESK

12. The point at which bending moment changes its sign is called:

A. Neutral point

B. Point of contraflexure

C. Centroid

D. Point of maximum moment

Answer: B. Point of contraflexure

13. The bending stress at the neutral axis of a beam is:

A. Maximum

B. Minimum

C. Zero

D. Constant

Answer: C. Zero

14. The bending stress in a beam is directly proportional to:

A. Distance from neutral axis

B. Square of distance from neutral axis

C. Inverse of distance

D. Radius only

Answer: A. Distance from neutral axis

15. Section modulus of a rectangular section is:

A. $bd^2/6$

B. $bd^3/12$

C. $bd^2/12$

D. $bd^3/6$

Answer: A. $bd^2/6$

POLYTECHNIC HELPDESK

16. Section modulus of a square section of side a is:

A. $a^2/6$

B. $a^3/6$

C. $a^4/12$

D. $a^3/12$

Answer: B. $a^3/6$

17. Slope of a beam is measured in:

A. Metre

B. Newton

C. Radian

D. N/mm^2

Answer: C. Radian

POLYTECHNIC HELPDESK

18. In a simply supported beam carrying UDL over the entire span, the maximum slope occurs at:

A. Centre

B. Supports

C. Quarter span

D. Everywhere

Answer: B. Supports

19. The equivalent length of a column fixed at both ends is:

A. L

B. 2L

C. L/2

D. $L/\sqrt{2}$

Answer: C. L/2

20. The equivalent length of a column with both ends hinged is:

A. L/2

B. L

C. 2L

D. L/√2

Answer: B. L

21. The equivalent length of a column with one end fixed and the other hinged is approximately:

A. L/2

B. L

C. L/√2

D. 2L

Answer: C. L/√2

22. The unit of slenderness ratio is:

A. mm

B. N

C. N/mm²

D. No unit

Answer: D. No unit

23. A structural member subjected to axial compressive force is called:

A. Beam

B. Column

C. Tie

D. Shaft

Answer: B. Column

POLYTECHNIC HELPDESK

24. The failure of a long column generally occurs due to:

A. Crushing

B. Buckling

C. Shearing

D. Torsion

Answer: B. Buckling

25. Euler's formula is mainly applicable to:

A. Short columns

B. Long columns

C. Beams only

D. Dams

Answer: B. Long columns

POLYTECHNIC
HELPDESK

26. The relation between number of members (n) and joints (j) in a perfect plane frame is:

A. $n = j$

B. $n = 2j - 3$

C. $n = 3j$

D. $j = 2n - 3$

Answer: B. $n = 2j - 3$

27. If the number of members in a frame is more than required for a perfect frame, it is called:

A. Perfect frame

B. Deficient frame

C. Redundant frame

D. Simple frame

Answer: C. Redundant frame

28. A redundant frame is:

A. Statically determinate

B. Statically indeterminate

C. Always unstable

D. A perfect frame

Answer: B. Statically indeterminate

29. There will be no tension at the base of a dam when eccentricity e is:

A. $e > b/6$

B. $e = b$

C. $e \leq b/6$

D. $e > b/2$

Answer: C. $e \leq b/6$

POLYTECHNIC HELPDESK

30. The strength of a beam mainly depends upon its:

A. Length only

B. Section modulus

C. Colour

D. Density of air

Answer: B. Section modulus

PART 2: FILL IN THE BLANKS – 30 IMPORTANT QUESTIONS

1.The SI unit of stress is _____.

☑ Answer: N/m² (Pascal)

2.The bending stress at the neutral axis of a bent beam is _____.

☑ Answer: Zero

3.A cantilever of length L carrying a point load W at the free end has downward deflection equal to _____.

☑ Answer: $WL^3 / 3EI$

4.The point of contraflexure is a point where bending moment changes _____.

☑ Answer: Sign

5.The slenderness ratio of a short column is less than _____.

☑ Answer: 80

6.The ratio of stress to strain within elastic limit is called _____.

☑ Answer: Modulus of Elasticity / Young's Modulus

POLYTECHNIC HELPDESK

7.Resistance per unit area to deformation is known as _____.

☑ Answer: Stress

8.The deformation per unit original length is known as _____.

☑ Answer: Strain

9.The constant of proportionality in Hooke's law is called _____.

☑ Answer: Modulus of Elasticity

10.Bending stress in a beam is proportional to the distance from the _____.

☑ Answer: Neutral axis

11.The structural member subjected to axial compressive force is called a _____.

☑ Answer: Column

12.The bending moment of a simply supported beam carrying UDL over the whole span is maximum at the _____.

☑ Answer: Centre

13.The bending moment of a beam not accompanied by shear force is known as _____.

☑ Answer: Pure bending

14.Neutral axis of a beam is the axis at which stress is _____.

☑ Answer: Zero

15.Slope of a beam is measured in _____.

☑ Answer: Radian

16.A _____ is constructed to retain earth in hilly areas.

☑ Answer: Retaining wall

POLYTECHNIC HELPDESK

17.The ratio of lateral strain to longitudinal strain is called _____.

☑ Answer: Poisson's ratio

18.The effective length of a column with both ends hinged is _____.

☑ Answer: L

19.The effective length of a column with both ends fixed is _____.

☑ Answer: L/2

20.The effective length of a column with one end fixed and the other hinged is _____.

☑ Answer: L/√2

21.The failure of a long column takes place due to _____.

☑ Answer: Buckling

22.Euler's buckling formula is applicable to _____ columns.

☑ Answer: Long

23.The relation for a perfect plane frame is n = _____.

☑ Answer: 2j − 3

24.A frame having more members than required for a perfect frame is called a _____ frame.

☑ Answer: Redundant

25.The maximum bending moment in a cantilever occurs at the _____ end.

☑ Answer: Fixed

26.The maximum shear force in a cantilever carrying a point load at its free end is equal to _____.

☑ Answer: W

27.The section modulus is equal to moment of inertia divided by _____.

☑ Answer: Distance of extreme fibre from neutral axis (ymax)

POLYTECHNIC HELPDESK

28.For a rectangular section, section modulus is equal to _____.

☑ Answer: $bd^2/6$

29.There will be no tension at the base of a dam when eccentricity e is _____.

☑ Answer: ≤ b/6

30.The property of a material by which it returns to its original shape after removal of load is called _____.

☑ Answer: Elasticity

PART 3: TRUE / FALSE – 30 IMPORTANT QUESTIONS ☑

1. Bending stress is directly proportional to the radius of curvature.

❌ False

Correct: Bending stress is inversely proportional to the radius of curvature.

2. The slope of a simply supported beam carrying UDL throughout its length is maximum at the ends.

☑ True

3. At the point of contraflexure, bending moment is maximum.

❌ False

Correct: At the point of contraflexure, bending moment changes sign.

4. A redundant frame is statically indeterminate.

☑ True

5. In the method of joints, the joint selected for analysis should preferably not contain more than two unknown member forces.

☑ True

6. Bending moment is maximum at a section where shear force is zero.

☑ True

7. The bending stress at the neutral axis is maximum.

❌ False

Correct: Bending stress at the neutral axis is zero.

POLYTECHNIC HELPDESK

8. The bending moment diagram for concentrated loads consists of straight lines between the loads.

☑ True

9. The bending moment diagram for a UDL is a parabolic curve.

☑ True

10. The maximum bending moment in a cantilever carrying a point load at its free end occurs at the free end.

✗ False

Correct: It occurs at the fixed end.

11. The maximum shear force in a cantilever carrying a point load W at its free end is W.

☑ True

12. Hooke's law is valid within the elastic limit.

☑ True

13. Poisson's ratio states that stress is proportional to strain.

✗ False

Correct: Hooke's law states that stress is proportional to strain within the elastic limit.

POLYTECHNIC HELPDESK

14. Poisson's ratio is the ratio of lateral strain to longitudinal strain.

☑ True

15. Long columns generally fail by buckling.

☑ True

16. Euler's formula is mainly applicable to short columns.

✗ False

Correct: Euler's formula is applicable to long columns.

17. The effective length of a column hinged at both ends is equal to its actual length.

☑ True

18. The effective length of a column fixed at both ends is equal to 2L.

✗ False

Correct: The effective length is L/2.

19. Slenderness ratio has no unit.

☑ True

20. A structural member subjected to axial compressive force is called a column.

☑ True

21. Section modulus is equal to Moment of Inertia divided by the distance of the extreme fibre from the neutral axis.

☑ True

Formula: $Z = I/y_{max}$

22. For a rectangular section, section modulus is $bd^3/12$.

✗ False

Correct: $Z = bd^2/6$

POLYTECHNIC HELPDESK

23. The section modulus of a square section of side a is $a^3/6$.

☑ True

24. Slope is measured in radians.

☑ True

25. The maximum deflection of a simply supported beam carrying a central point load occurs at the centre.

☑ True

26. The point of contraflexure occurs only in beams where bending moment changes from positive to negative or vice versa.

☑ True

27. A frame having more members than required for a perfect frame is called a deficient frame.

❌ False

Correct: It is called a redundant frame.

28. The condition for a perfect plane frame is n = 2j − 3.

☑ True

29. There will be no tension at the base of a dam when the eccentricity is within the middle third.

☑ True

Condition: e ≤ b/6

30. The bending moment of a beam not accompanied by shear force is called pure bending.

☑ True

STRUCTURAL MECHANICS (CV-402)

COMPLETE IMPORTANT PREPARATION NOTES

PART 2 – PART 7

POLYTECHNIC
HELPDESK

PART 2: MOST IMPORTANT DEFINITIONS

1. Stress

Stress is the internal resisting force developed per unit cross-sectional area of a body when it is subjected to an external force.

Formula:

\[\sigma = \frac{P}{A}\]

Unit: N/m² or Pascal (Pa)

---

2. Strain

Strain is the ratio of change in dimension to the original dimension of a body due to an applied load.

Formula:$$\varepsilon = \frac{\Delta L}{L}$$

Unit: No unit

---

3. Elasticity

Elasticity is the property of a material by which it regains its original shape and size after removal of the deforming force, provided the elastic limit is not exceeded.

4. Plasticity

Plasticity is the property of a material by which it undergoes permanent deformation without rupture after the removal of the applied load.

5. Ductility

Ductility is the property of a material by which it can be drawn into thin wires without breaking.

Example: Steel

6. Brittleness

Brittleness is the property of a material by which it breaks or fractures suddenly with very little deformation.

Example: Cast iron

POLYTECHNIC HELPDESK

7. Young's Modulus

Young's Modulus is the ratio of longitudinal stress to longitudinal strain within the elastic limit.

$$E = \frac{\text{Longitudinal Stress}}{\text{Longitudinal Strain}}$$

8. Modulus of Rigidity

Modulus of Rigidity is the ratio of shear stress to shear strain within the elastic limit.

$$G = \frac{\text{Shear Stress}}{\text{Shear Strain}}$$

9. Bulk Modulus

Bulk Modulus is the ratio of direct stress to volumetric strain within the elastic limit.

$$K = \frac{\text{Direct Stress}}{\text{Volumetric Strain}}$$

10. Poisson's Ratio

Poisson's Ratio is the ratio of lateral strain to longitudinal strain produced in a material due to an axial load.

$$\mu = \frac{\text{Lateral Strain}}{\text{Longitudinal Strain}}$$

11. Shear Force

Shear force at a section of a beam is the algebraic sum of all vertical forces acting on either side of that section.

12. Bending Moment

Bending moment at any section of a beam is the algebraic sum of the moments of all forces acting on either side of that section about the section.

13. Neutral Axis

Neutral axis is the line in the cross-section of a bent beam at which bending stress is zero.

14. Point of Contraflexure

The point of contraflexure is the point on a beam where the bending moment changes its sign from positive to negative or vice versa.

POLYTECHNIC HELPDESK

15. Pure Bending

Pure bending is the condition in which a portion of a beam is subjected to a constant bending moment and zero shear force.

16. Section Modulus

Section modulus is the ratio of moment of inertia of a section about the neutral axis to the distance of the extreme fibre from the neutral axis.

$$Z = \frac{I}{y_{\max}}$$

17. Elastic Curve

The elastic curve is the curve formed by the longitudinal axis of a beam after it undergoes bending due to loading.

18. Slope of a Beam

The slope at any point of a beam is the angle between the tangent to the elastic curve and the original axis of the beam at that point.

Unit: Radian

19. Deflection

Deflection is the vertical displacement of a point on a beam from its original position due to the applied load.

20. Column

A column is a structural member subjected mainly to axial compressive load.

21. Effective Length of Column

Effective length is the length of an equivalent hinged column having the same buckling load as the actual column.

22. Slenderness Ratio

Slenderness ratio is the ratio of effective length of a column to its least radius of gyration.

$$\lambda = \frac{L_e}{k_{\min}}$$

23. Buckling

Buckling is the sudden lateral deflection or bending of a long column when the axial compressive load reaches a critical value.

24. Perfect Frame

A perfect frame is a plane frame which has just sufficient number of members to remain stable and statically determinate.

$$m = 2j - 3$$

Where:

m = Number of members

j = Number of joints

25. Redundant Frame

A frame having more members than required for a perfect frame is called a redundant frame. It is statically indeterminate.

26. Retaining Wall

A retaining wall is a structure constructed to retain soil or earth at different levels.

POLYTECHNIC HELPDESK

STRUCTURAL MECHANICS (CV-402)

IMPORTANT FORMULA SHEET

A. STRESS AND STRAIN

1. Stress

$$\sigma = \frac{P}{A}$$

P = Load
A = Area

2. Strain

$$\varepsilon = \frac{\Delta L}{L}$$

ΔL = Change in length
L = Original length

3. Elongation of Uniform Bar

$$\Delta L = \frac{PL}{AE}$$

E = Young's Modulus

4. Young's Modulus

$$E = \frac{\sigma}{\varepsilon}$$

5. Modulus of Rigidity

$$G = \frac{\tau}{\gamma}$$

6. Bulk Modulus

$$K = \frac{\sigma}{\text{Volumetric Strain}}$$

7. Poisson's Ratio

$$\mu = \frac{\text{Lateral Strain}}{\text{Longitudinal Strain}}$$

B. RELATION BETWEEN ELASTIC CONSTANTS

1. Between E and G

$$E = 2G(1 + \mu)$$

2. Between E and K

$$E = 3K(1 - 2\mu)$$

3. Between G and K

$$K = \frac{2G(1 + \mu)}{3(1 - 2\mu)}$$

C. BENDING THEORY

1. Bending Equation

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

M = Bending Moment
I = Moment of Inertia
σ = Bending Stress
y = Distance from N.A.
E = Young's Modulus
R = Radius of Curvature

2. Bending Stress

$$\sigma = \frac{My}{I}$$

3. Section Modulus

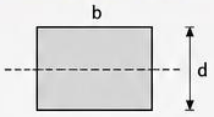
$$Z = \frac{I}{y_{max}}$$

4. Maximum Bending Stress

$$\sigma_{max} = \frac{M}{Z}$$

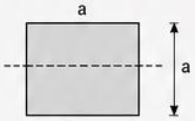
D. MOMENT OF INERTIA (I) AND SECTION MODULUS (Z)

1. Rectangular Section



$$I = \frac{bd^3}{12} \qquad Z = \frac{bd^2}{6}$$

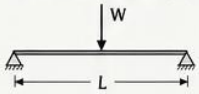
2. Square Section



$$I = \frac{a^4}{12} \qquad Z = \frac{a^3}{6}$$

E. IMPORTANT SFD & BMD FORMULAS

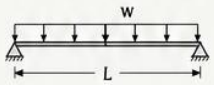
1. Simply Supported Beam — Central Point Load (W)



$$V_{max} = \frac{W}{2}$$

$$M_{max} = \frac{WL}{4}$$

2. Simply Supported Beam — UDL (w) Over Whole Span



$$V_{max} = \frac{wL}{2}$$

$$M_{max} = \frac{wL^2}{8}$$

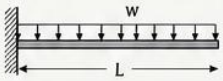
3. Cantilever Beam — Point Load (W) at Free End

$$V_{max} = W$$

$$M_{max} = WL$$

(At Fixed End)

4. Cantilever Beam — UDL (w) Over Whole Length



$$V_{max} = wL$$

$$M_{max} = \frac{wL^2}{2}$$

(At Fixed End)

F. SLOPE AND DEFLECTION FORMULAS

	1. Cantilever Beam — Point Load (W) at Free End	2. Cantilever Beam — UDL (w) Over Whole Span	3. Simply Supported Beam — Central Point Load (W)	4. Simply Supported Beam — UDL (w) Over Whole Span
Slope (Maximum)	$\theta = \frac{WL^2}{2EI}$	$\theta = \frac{wL^3}{6EI}$	$\theta_{max} = \frac{WL^2}{16EI}$	$\theta_{max} = \frac{wL^3}{24EI}$
Deflection (Maximum)	$y_{max} = \frac{WL^3}{3EI}$	$y_{max} = \frac{wL^4}{8EI}$	$y_{max} = \frac{WL^3}{48EI}$	$y_{max} = \frac{5wL^4}{384EI}$

G. EULER'S COLUMN FORMULA

1. Euler's Crippling Load

$$P_{cr} = \frac{\pi^2 EI}{L_e^2}$$

P_{cr} = Critical or Crippling Load
E = Young's Modulus
I = Least Moment of Inertia
L_e = Effective Length

H. EFFECTIVE LENGTH (L_e)

End Condition	Effective Length (L_e)
Both Ends Hinged	L
Both Ends Fixed	$L/2$
One End Fixed Other Hinged	$L/\sqrt{2}$
One End Fixed Other Free	$2L$

I. FRAME / TRUSS

1. Perfect Plane Frame

$$m = 2j - 3$$

m = Number of Members
j = Number of Joints

If,

$m > 2j - 3$ → Redundant Frame

$m < 2j - 3$ → Deficient Frame

J. DAM

For No Tension at the Base

$$e \leq \frac{b}{6}$$

e = Eccentricity of Resultant
b = Width of Base

POLYTECHNIC HELPDESK

All the Best for Your Exams!

STUDY SMART, SCORE HIGH

Use this formula sheet for learning purpose.

© Polytechnic Helpdesk

PART 5: IMPORTANT NUMERICAL TYPES

These are the main numerical problem types students should practise. The aim is to understand the method and formula, not only memorise the final answer.

TYPE 1: STRESS, STRAIN AND ELONGATION OF A BAR

Common Questions

Find stress in a bar.

Find strain.

Find elongation.

Find Young's Modulus.

Standard Steps

Step 1: Convert all units into a consistent system.

Step 2: Calculate the area of the bar if required.

Step 3: Calculate stress using \(P/A\).

Step 4: Calculate strain using \(\sigma/E\).

Step 5: Calculate elongation using \(PL/AE\).

POLYTECHNIC HELPDESK

TYPE 2: STEPPED BAR / COMPOSITE BAR DEFORMATION

A bar may consist of two or more portions having different:

Lengths

Areas

Loads

Important Point

Tensile force → Elongation

Compressive force → Shortening

Use the correct algebraic sign when requ

TYPE 3: POISSON'S RATIO AND CHANGE IN DIMENSIONS

Common Questions

Find lateral strain.

Find change in diameter.

Find change in width

Steps

1. Calculate longitudinal strain.

2. Use Poisson's ratio to find lateral strain.

3. Multiply lateral strain by the original lateral dimension.

TYPE 4: COMPOSITE COLUMN

A composite column may contain materials such as:

Steel

Concrete

Important Principle

Since the materials are connected together:

$$\text{Strain in both materials is the same}$$

Modular Ratio

$$m=\frac{E_s}{E_c}$$

Therefore, the stresses are proportional to their Young's Moduli.

General Steps

1. Calculate the cross-sectional area of each material.

2. Use strain compatibility.

3. Establish the stress relationship.

4. Apply equilibrium:

POLYTECHNIC HELPDESK

$$P=\sigma_sA_s+\sigma_cA_c$$

5. Calculate the required stresses.

TYPE 5: MAXIMUM BENDING STRESS

Common Questions

Find maximum bending stress.

Find bending stress at a particular fibre.

Steps

1. Calculate support reactions.
2. Draw or calculate the bending moment.
3. Find the maximum bending moment.
4. Calculate I or Z.
5. Apply the bending formula.

Important Unit Check

If M is in N-mm, use I in mm^4 and y in mm.

POLYTECHNIC HELPDESK

TYPE 6: SLOPE AND DEFLECTION OF CANTILEVER

Case 1: Point Load at Free End

Maximum Slope

$$\theta=\frac{WL^2}{2EI}$$

Maximum Deflection

$$y_{max}=\frac{WL^3}{3EI}$$

Case 2: UDL Over Whole Span

Maximum Slope

$$\theta=\frac{wL^3}{6EI}$$

Maximum Deflection

$$y_{max}=\frac{wL^4}{8EI}$$

Steps

1. Identify the loading condition.
2. Select the correct formula.
3. Maintain consistent units.
4. Substitute the values carefully.

TYPE 7: SLOPE AND DEFLECTION OF SIMPLY SUPPORTED BEAM

Case 1: Central Point Load

Maximum Slope

$$\theta_{max}=\frac{WL^2}{16EI}$$

Maximum Deflection

$$y_{max}=\frac{WL^3}{48EI}$$

Case 2: UDL Over Whole Span

Maximum Slope

$$\theta_{max}=\frac{wL^3}{24EI}$$

Maximum Deflection

$$y_{max}=\frac{5wL^4}{384EI}$$

Important Point

The maximum deflection occurs at the centre of the span for these symmetrical loading cases.

POLYTECHNIC HELPDESK

TYPE 8: SFD AND BMD PROBLEMS

This is one of the most important practice areas.

Standard Procedure

Step 1: Draw the Beam

Show all:

Supports

Loads

Dimensions

Step 2: Calculate Reactions

Use:\[\Sigma V=0\]

\[\Sigma M=0\]

Step 3: Calculate Shear Force

Calculate SF at all important sections.

POLYTECHNIC HELPDESK

Step 4: Draw SFD

Remember:

Point load → Sudden jump in SFD

UDL → Inclined straight line in SFD

Step 5: Calculate Bending Moment

Calculate BM at important points.

Step 6: Draw BMD

Remember:

Point load → Straight line BMD

UDL → Parabolic BMD

Important Condition

\[SF=0\]

At the location of maximum or minimum bending moment, provided the shear force changes sign.

TYPE 9: EULER'S COLUMN PROBLEMS

Euler's Formula

$$P_{cr}=\frac{\pi^2EI}{L_e^2}$$

Effective Lengths

End Condition	Effective Length
Hinged–Hinged	L
Fixed–Fixed	$L/2$
Fixed–Hinged	$L/\sqrt2$
Fixed–Free	$2L$

Steps

1. Identify the end condition.
2. Calculate effective length.
3. Calculate the least moment of inertia.
4. Apply Euler's formula.

POLYTECHNIC HELPDESK

TYPE 10: HOLLOW CIRCULAR COLUMN

Moment of Inertia

$$I=\frac{\pi(D^4-d^4)}{64}$$

Where:

D = External diameter

d = Internal diameter

Then use:

$$P_{cr}=\frac{\pi^2EI}{L_e^2}$$

TYPE 11: MASONRY DAM – BASE PRESSURE

Common Requirements

Find resultant force.

Find eccentricity.

Find maximum stress.

Find minimum stress.

Formula

$$\sigma_{max/min}=\frac{W}{B\left(1\pm\frac{6e}{B}\right)}$$

No Tension Condition

$$e\leq\frac{B}{6}$$

Steps

1. Calculate the total vertical load W.
2. Calculate moments of all forces.
3. Find the position of the resultant.
4. Calculate eccentricity e.
5. Find maximum and minimum base stresses.

POLYTECHNIC HELP DESK

TYPE 12: TRUSS – METHOD OF JOINTS

Main Equations

$$\Sigma F_x=0$$

$$\Sigma F_y=0$$

Steps

1. Draw the complete truss.
2. Calculate support reactions.
3. Select a joint having not more than two unknown forces.
4. Assume unknown forces as tension initially.
5. Apply horizontal and vertical equilibrium equations.
6. Continue joint by joint.

Important Result

Positive according to assumed tension → Tension

Opposite direction → Compression

PART 6: MOST IMPORTANT LONG QUESTIONS

PRIORITY 1 – MUST PREPARE

1. Explain Stress and Strain and derive their relationship with Young's Modulus.

Prepare:

Definition of stress

Definition of strain

Formula

Young's Modulus

Units

2. State and Explain Hooke's Law.

Prepare:\[\sigma\propto\varepsilon\]

Within the elastic limit:

\\sigma=E\varepsilon\]

POLYTECHNIC HELPDESK

3. State the Assumptions of Simple Bending Theory.

Prepare at least five assumptions:

1. Material is homogeneous.

2. Material is isotropic.

3. Material obeys Hooke's Law.

4. Plane sections remain plane after bending.

5. Radius of curvature is large compared with the beam depth.

6. Young's Modulus is the same in tension and compression.

4. Derive the Section Modulus of a Rectangular Section.

5. Draw SFD and BMD for a Simply Supported Beam Carrying Point Loads.

Prepare:

Support reactions

Shear force calculation

Bending moment calculation

SFD

BMD

6. Draw SFD and BMD for a Simply Supported Beam Carrying UDL.

Important formula:

$$M_{max}=\frac{wL^2}{8}$$

7. Draw SFD and BMD for a Cantilever Beam.

Prepare both cases:

Point load at free end

UDL over the entire span

8. Define and Explain Point of Contraflexure.

Answer:

The point of contraflexure is the point on a beam where the bending moment changes its sign from positive to negative or vice versa.

POLYTECHNIC HELPDESK

10. Explain the Methods of Finding Slope and Deflection.

Prepare:

1. Double Integration Method

2. Macaulay's Method

3. Moment Area Method

4. Conjugate Beam Method

11. Determine Slope and Deflection of a Cantilever Beam.

Prepare both:

Point load at free end

UDL over the whole span

12. Determine Slope and Deflection of a Simply Supported Beam.

Prepare:

Central point load

UDL over the whole span

13. Explain Euler's Column Theory and Its Assumptions.

Prepare:

Definition of long column

Euler's formula

Assumptions

Effective length

Critical load

14. Calculate Euler's Crippling Load for Different End Conditions.

Important formula:

$$P_{cr}=\frac{\pi^2EI}{L_e^2}$$

POLYTECHNIC HELPDESK

15. Explain Perfect, Redundant and Deficient Frames.

Perfect Frame

$$m=2j-3$$

Redundant Frame

$$m>2j-3$$

Deficient Frame

$$m<2j-3$$

16. Determine Forces in a Truss Using the Method of Joints.

Prepare:

Support reactions

Joint equilibrium

Tension and compression

17. Explain the Stability of a Masonry Dam.

Prepare:

Resultant force

Eccentricity

Base pressure

No tension condition

18. Determine Maximum and Minimum Base Pressure of a Masonry Dam.

Important formula:

\\sigma_{max/min=\frac{W}{B}\left(1\pm\frac{6e}{B}\right)\]

Before the exam, make sure you can:

☐ Define Stress and Strain

☐ Write Hooke's Law

☐ Write all Elastic Constant Relations

☐ Write the Bending Equation

☐ Calculate Section Modulus

☐ Draw SFD and BMD

☐ Solve Slope and Deflection problems

☐ Apply Euler's Column Formula

☐ Remember all Effective Length Conditions

☐ Identify Perfect, Redundant and Deficient Frames

☐ Solve a basic Truss by Method of Joints

☐ Calculate Dam Base Pressure and Eccentricity

POLYTECHNIC HELPDESK

FINAL PRIORITY FOR STUDENTS

MUST PRACTISE FIRST

1. SFD and BMD
2. Bending Stress and Section Modulus
3. Slope and Deflection
4. Euler's Column
5. Stress, Strain and Elongation
6. Truss by Method of Joints

THEN REVISE

7. Composite Column
8. Masonry Dam
9. Poisson's Ratio
10. Frames

POLYTECHNIC
HELPDESK